

## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[Industrial Application] false [ which offers the absorption in which the saturation of this invention of the light corpuscle child of a fixed condition, especially a single solid state light corpuscle child is possible, polarization, and retroreflection ] -- it is related with a monolithic light corpuscle child.

[0002]

[Description of the Prior Art] Each function (the absorption in which saturation is possible, polarization, retroreflection) of each performed by this invention is usually well known for the technique. The absorber in which saturation is possible is known for the technique. The direction of a brewster angle for polarization selection is also known well. A base can adhere to dielectric high reflective covering without difficulty using the usual technique. Although each equipment which performs each above-mentioned function exists, it is thought that the fault and difficulty about alignment of three functionally different components are obvious.

[0003] For example, the U.S. Pat. No. 4,084,883 specification is indicating the reflexivity polarization layer for laser components. The U.S. Pat. No. 4,104,598 specification is indicating the laser which has association with a reflector and wire grid polarization equipment. A U.S. Pat. No. 4,875,220 specification indicates two unified laser mirrors, and this unified mirror has the polarization front face. The U.S. Pat. No. 5,097,481 specification is indicating the technique similar to a U.S. Pat. No. 4,875,220 specification. The U.S. Pat. No. 5,101,415 specification is indicating the laser mirror which has the reflexivity front face which operates in the 1st and 2nd wavelength mode.

[0004] In addition to the above-mentioned patent specification, the conventional research on the absorber in which the saturation of a solid state is possible is indicated by the following reference. In reference ("Formation, optical properties, and laser operation of F2-centers in LiF", J.Appl.Phys 61, 1297, (1987)), it is a structure condition, an optical property, and F2 under LiF crystal. - Investigation of laser actuation of a color center is indicated. In another reference ("Phototropic centers in chromium-doped garnets", Opt Spectrosc (Soviet Union), and 63,695) (1987), it is KUROMUDO as a passive Q switch. - The use of a garnet which carried out PU is explained. It is F2 [ important / for a solid state laser design ] because of the saturation actuation by the saturation state of high intensity level in reference ("Room temperature Q-switching of Nd:YAG by F2-color centers in LiF", CLEO, San Francisco, California, WM5 (1986)). - Research of the Q switch property of a color center ingredient is explained. F2 of the gamma ray exposure LiF generated by reference ("Room Temperature Laser Action and Q-Switching of F-Aggregate Color Centers in LiF", the 5th international congress in dynamic processing of a solid excitation state, Lyon, France, 1-July 4, 1985) by the Nd:YAG pulse for 30 nanoseconds - It is directed in the passive switching by the core. The light color nature property of GSGG:Cr and Nd crystal is indicated by reference ("Photochromic properties of a gadolinium-scandium-gallium garnet crystal", Preprint#238, the Soviet Union, Academy of Science, Institute of General Physics, Moscow (1985)).

[0005]

[Problem(s) to be Solved by the Invention] However, the above-mentioned conventional technique does not indicate association of three functions (the absorption in which saturation is possible, polarization, retroreflection) to one component, and the equipment of such a conventional technique does not exist. so, false [ which performs absorption in which saturation is possible, and polarization retroreflection by the light corpuscle child of a solid state with the single purpose of this invention ] -- it is giving the light corpuscle child in whom monolithic saturation's is possible.

[0006]

[Means for Solving the Problem] In order to fill the above-mentioned and other purposes, this invention offers the light corpuscle child for using it by the laser cavity which has the optical axis which a laser beam spreads. A light corpuscle child performs retroreflection of the absorption in which saturation is possible, polarization, and a laser beam into the unified package. A light corpuscle child has the base

which has the anterior part front face and posterior part front face which are arranged by whenever [ point-angle / which was defined beforehand ] and which is not doped. The base is comparatively transparent to the laser beam given by the laser cavity. The posterior part front face of the base which is not doped adheres to dielectric covering, and the absorber plate member in which at least one saturation is possible is arranged at the front of a base. The absorber plate member in which saturation is possible is arranged about the optical axis of a laser cavity at a brewster angle. The absorption in which the saturation of a laser beam is possible is given by the light corpuscle child using the absorber plate member in which saturation is possible, polarization of a laser beam is given by orienting a light corpuscle child's front face on a brewster square about the optical axis of a laser cavity, and the retroreflection of a laser beam is given by dielectric covering.

[0007] Therefore, this invention unites three separated optical functions containing the absorption in which saturation is possible, polarization, and retroreflection with a single solid state light corpuscle child. The absorber which is given by the plate member and in which saturation is possible is F2 in lithium fluoride. - It is one doping agent ion of Cr<sup>4+</sup> in a color center or some suitable host light ingredients. A suitable single crystal host ingredient For example, a yttrium aluminum garnet (YAG), An yttrium scandium aluminum NIUMUGA-network (YSAG), an yttrium scandium GARIUMUGA-network (YSGG), A gadolinium scandium aluminum NIUMUGA-network (GSAG), a gadolinium scandium GARIUMUGA-network (GSGG), The combination of the suitable single crystal of a gadolinium gallium garnet (GGG), a gadolinium indium GARIUMUGA-network (GIGG), an yttrium orthosilicic acid salt (YOS), Mg<sub>2</sub>SiO<sub>4</sub>, or (forsterite) the above-mentioned matter is included. A host light ingredient may be glass or an amorphous ingredient. Suitable linearity polarization of a laser beam is attained by setting a light corpuscle child's input screen by the brewster angle. Dielectric covering (mirror) to which it adhered on a light corpuscle child's rear face offers the reflexivity of 100 %.

[0008] Therefore, in using it by the laser cavity, a light corpuscle child is easy to manufacture and constitutes a monolithic object with easy alignment of a multiplex functional device. In addition to passive Q-switching, this invention discriminates from linearity polarization and carries out the duty as a 100 % reflexivity mirror or a reflector. Since a mirror is a light corpuscle child's unification part, the easy, important effectiveness of the unified polariscope which aligns is acquired. By aligning the light corpuscle child of retroreflection so that it may be typically carried out by the vertical-incidence 100 % reflexivity mirror, brewster include-angle conditions are fulfilled automatically and the optimal polarization discrimination is attained. With a typical brewster angle component, whenever [ incident angle ] must be made separately the optimal. The optimal phase is not needed in this invention.

[0009] This invention offers the light corpuscle child who improves quality, is more efficient and uses the laser equipment used as a compact. Furthermore, this invention can be easy to align and the number of light corpuscle children in laser equipment can be decreased. The reduction in an element number gives dependability to the improved system.

[0010] Combining with a single light corpuscle child three functions (the absorption in which saturation is possible, polarization, retroreflection) conquers the fault and difficulty about aligning three different components functionally with usual laser equipment. The advantage of this invention is clear as compared with usual equipment, and comparatively easy alignment of the single unification equipment of especially this invention is very superior to the technique used with usual equipment.

[0011]

[Example] Various descriptions and advantages of this invention will be easily understood with reference to the below-mentioned detailed explanation accompanied by an accompanying drawing. Laser structure possesses the laser medium located between one pair of mirrors which limit a laser cavity cavity. One mirror reflects all laser beams substantially, and it is called a "quantity reflector", and the 2nd mirror is called "wired-AND equipment" as explained by the U.S. Pat. No. 5,101,415 specification which penetrated partially, reflected partially and mentioned the laser beam above. According to this invention, the light corpuscle child of the multiplex function of this invention permutes, and a high reflector mirror is improved so that it may mention later in a detail.

[0012] Reference of drawing 1 shows the false monolithic light corpuscle child 10 by the principle of

this invention. The false MONOSHI rucksack light corpuscle child 10 possesses the absorber plate member 11 in which the saturation of the number of arbitration is possible, and is shown. Since the vocabulary "a false monolithic" is not, a piece with the single light corpuscle child 10, i.e., the true MONOSHI rucksack, of this invention, it is used. The false monolithic light corpuscle child 10 is located in the edge of a laser cavity 12, and is shown, and the optical axis 13 of the laser cavity 12 which has laser beam 13a to spread is also shown.

[0013] The false monolithic light corpuscle child 10 contains the base 14 which consists of a host light ingredient which has the almost same refractive index as the absorber plate member 11 which is mentioned later, and in which saturation is possible, and which is not doped. The base 14 is transparent to laser beam 13a. A base 14 is point-angle [ which was related mutually and defined beforehand ] whenever  $\theta_A$ . It is formed in the wedge configuration which has the transverse plane and the posterior part front faces 14a and 14b which are arranged. A base 14 has the dielectric covering 15 of the 100 % reflexivity arranged at rear-face 14b. The dielectric covering 15 possesses for example, diacid-ized titanium, diacid-ized silicon ( $\text{TiO}_2 / \text{SiO}_2$ ) or diacid-ized silicon, and the dielectric materials of the standard multiplex layer formed from a zirconium dioxide ( $\text{SiO}_2 / \text{ZrO}_2$ ), and rear-face 14b adheres to these using a known covering adhesion technique.

[0014] The absorber plate members 11a, 11b, and 11c in which two or more saturation is possible are accumulated on a mutual top face, for example, are being fixed to transverse-plane 14a of a base 14 by each layer of optical cement 16. Drawing 1 is the purpose of only instantiation and shows use of the absorber plate members 11a, 11b, and 11c in which three saturation is possible. He can understand that the absorber plate member 11 in which two or more of other saturation is possible is used including the single plate member 11 depending on the type of laser resonance equipment 12, and the absorber which is used by the absorber plate member 11 in which saturation is possible and in which saturation is possible. To laser beam 13a, optical cement 16 is transparent and its refractive index corresponds with the title top base 14. Optical cement 16 like the epoxy ingredient obtained from California and HATERUENTA-PURAIKU (Hartel) of PAKOIRA is used. The flat surface 17 perpendicular to the maximum top face or the exposure front face of the absorber plate member 11 in which front saturation is possible is shown, and the light corpuscle child 10 is include-angle  $\theta_B$  between the perpendicular 17 of a resonator 12, and an optical axis 13. It is located in a laser cavity 12. The incident angle of the laser beam 13 in the front face of the dielectric covering 15 is 90 degrees as shown by drawing 1.  $\theta_A$  and  $\theta_B$  The limited specific value is mentioned later.

[0015] A base 14 is not doped by two reasons. It is F2 of LiF to the 1st. - Annealing of these cores is carried out at rise temperature required to form the hard dielectric covering 15 about a color center. If doped with the absorber ingredient in which the saturation of a base 14 is [ 2nd ] possible, an optical consistency will change as a function of the crossing dimension which crosses opening. The light corpuscle child 10 is spatially bleached optically by the uneven approach as a result. Therefore, the light corpuscle child 10 consists of above-mentioned approaches.

[0016] The light corpuscle child 10 of this invention offers three optical functions which united the whole with the single optical components which can align into the laser resonance equipment shown by 12 by optimizing the retroreflection feedback from the light corpuscle child's 10 high reflexivity posterior part surface 14b given by the reflexivity dielectric covering 15 of 100 %. Unification welds a base 14 and the absorber plate member 11 of each other in which one or more saturation is possible, and it is attained using optical cement 16 in order to form the single false monolithic component 10.

[0017] As the light corpuscle child 10 shows low loss as mentioned above on the boundary between the plate members 11, optical cement 16 makes a refractive index in agreement with a base 14. It must compromise with the advantage of polarization discrimination additional for the passive loss which increased on the condition that the refractive index is not in agreement. Each detailed field of three functions each performed by the light corpuscle child 10 is explained.

[0018] The absorption in which saturation is possible is F2 which uses for example, an electron beam exposure. - It is attained by generation of a color center, or  $\text{Cr}^{4+}$  doping under suitable crystal like the gadolinium scandium GARIUMUGA-network which constitutes the absorber plate member 11 in which

saturation is possible. The desirable single crystal host light ingredient especially for bases 14 For example, a yttrium aluminum garnet (YAG), An yttrium scandium aluminum NIUMUGA-network (YSAG), an yttrium scandium GARIUMUGA-network (YSGG), A gadolinium scandium aluminum NIUMUGA-network (GSAG), a gadolinium scandium GARIUMUGA-network (GSGG), The combination of gadolinium gallium garnet (GGG), gadolinium indium GARIUMUGA-network (GIGG), yttrium orthosilicic acid salt (YOS), and  $\text{Mg}_2\text{SiO}_4$  or (forsterite) the suitable above-mentioned single crystal is included. Instead, a host light ingredient may be glass or an amorphous ingredient.

[0019] F2 - In the manufacture relevant to a color center, the maximum optical consistency is offered per plate member 11 by the plate member 11 with a thickness [ of irradiated LiF ] of 2-3mm. A synthetic optical consistency required for specific application is attained by including a large number or some plate members 11 in a design of the light corpuscle child 10.  $\text{Cr}^{4+}$  - In the doped garnet, the property of crystal growth makes it possible to be attained by the plate member 11 with a rational optical single consistency on parenchyma. The absorber ingredient in which saturation is possible shows passive Q-switching on the laser wavelength of about 1 micrometer, and can perform it on other wavelength. F2 - The range of a color center absorption band region is about 900-1100nm, and, on the other hand, the absorption band region of  $\text{Cr}^{4+}$  extends in 900-1200nm. Drawing 2 is LiF:F2. - The room temperature absorption spectrum of a color center is shown, and drawing 3 is  $\text{Cr}^{4+}$ . - The room temperature absorption spectrum of doped  $\text{Cr:Nd:GSGG}$  (gadolinium scandium GARIUMUGA-network) is shown. [0020] Polarization discrimination of the laser beam which polarized to linearity is obtained by orienting the light corpuscle child's 10 front face 21 on a brewster square about the optical axis 13 of a laser cavity 12 so that "p" polarization may be penetrated without loss. However, in fact, this condition is automatically satisfied, when the light corpuscle child 10 is made the optimal because of the suitable retroreflection of a laser beam 13. For example, the refractive index and brewster angle of the LiF base 14 are 1.386 at 1.06 micrometers, respectively. It is 54.2 degrees. In other garnets especially like a gadolinium scandium GARIUMUGA-network, values are 1.94 and 62.7 degrees similarly, respectively. [0021] In order to obtain reflection of 100 % from the light corpuscle child's 10 posterior part surface 14b, the dielectric laser covering 15 is vapor-deposited by the base 14 which consists of host ingredients which have the almost same refractive index as the absorption plate member 11 in which saturation is possible as mentioned above, and which are not doped. The covered base 14 forms the mirror or reflector pasted up on the absorber plate member 11 in which saturation is possible with optical cement 16 after covering processing. The reflector which constitutes the covering base 14 and which is not doped is designed so that the front face 21 of front 14a10, i.e., a light corpuscle child, may align on a brewster square automatically by suitable orientation (that is, the angle of incidence of the laser beam 13 in covering surface 14b 90 degrees) of retroreflection. Generally, it is point-angle whenever  $\theta_A$ . It is limited characteristic using easy geometric logic, is given by  $\sin^{-1}\{\sin \theta_B/n\}$ , and is  $\theta_B$  here. It is a brewster angle and  $n$  is the refractive index of a base 14. At the plate member 11 which consists of LiF and GSGG, it is  $\theta_A$ . They are 18.4 degrees and 27.3 degrees in  $\lambda = 1.06$  micrometers, respectively. In actuation, the compensation wedge 22 which has whenever [ same as base 14 presentation and point-angle ] is inserted in the path of a laser beam 13, and in order to ease the heat beam operation effectiveness, it has an opposite direction (namely, related with a base 180 \*\* rotations) about a base 14.

[0022] The improved light corpuscle child who offers above the absorption in which saturation is possible, polarization, and retroreflection by the single solid state light corpuscle child and in whom false monolithic saturation is possible was explained. He can understand that the above-mentioned example is mere instantiation of many specific examples showing application of the principle of this invention. Clearly, this contractor can carry out easily, without many of other equipments deviating from the technical range of this invention.

CLAIMS

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## (57) [Claim(s)]

[Claim 1] In the light corpuscle child who is used with the laser resonance equipment which has the optical axis which a laser beam spreads, and gives the absorption in which the saturation of a laser beam is possible, polarization, and retroreflection As opposed to the laser beam which possesses the anterior part front face and posterior part front face which are arranged by whenever [ point-angle / which was related mutually and defined beforehand ], and is given by the laser cavity The comparatively transparent base which is not doped, Dielectric covering which was constituted so that it might be arranged on the posterior part front face of a base and a laser beam might be reflected and which is not doped, It has the front face constituted so that it might be arranged on a brewster square about the optical axis of a laser cavity. The absorber plate member which was located in the anterior part front face of the base which is not doped and in which saturation is possible is provided. The absorption in which the saturation of a laser beam is possible is given by the absorber in which saturation is possible. He is the light corpuscle child characterized by giving polarization of a laser beam by orienting a light corpuscle child's anterior part front face on a brewster square about the optical axis of a laser cavity, and the retroreflection of a laser beam being given by dielectric covering.

[Claim 2] The absorber plate member in which saturation is possible is F2 arranged so that it may have the optical consistency as which the base was determined beforehand. - Light corpuscle child containing the lithium fluoride which has a color center according to claim 1.

[Claim 3] The absorber plate member in which saturation is possible is a light corpuscle child containing the host light ingredient which has the Cr<sup>4+</sup> dope ion arranged so that it may have the optical consistency as which the base was determined beforehand according to claim 1.

[Claim 4] The light corpuscle child according to claim 3 whose host light ingredient is a single crystall luminescence ingredient.

[Claim 5] A single crystal light ingredient A yttrium aluminum garnet (YAG), an yttrium scandium aluminum NIUMUGA-network (YSAG), An yttrium scandium GARIUMUGA-network (YSGG), a gadolinium scandium aluminum NIUMUGA-network (GSAG), A gadolinium scandium GARIUMUGA-network (GSGG), a gadolinium gallium garnet (GGG), Gadolinium indium GARIUMUGA-network (GIGG), yttrium orthosilicic acid salt (YOS), and Mg<sub>2</sub> SiO<sub>4</sub> And light corpuscle child according to claim 4 chosen from the group who consists of combination of these single crystals.

[Claim 6] The light corpuscle child according to claim 3 whose host light ingredient is a vitreous optical material.

[Claim 7] The light corpuscle child according to claim 1 who consists of ingredients which have the almost same refractive index as the absorber plate member in which the saturation of the base which is not doped is possible.

[Claim 8] The light corpuscle child according to claim 1 by whom dielectric covering is constituted from a multiplex layer of diacid-ized titanium and diacid-ized silicon.

[Claim 9] The light corpuscle child according to claim 1 by whom dielectric covering is constituted from a multiplex layer of diacid-ized silicon and a zirconium dioxide.

[Claim 10] The light corpuscle child according to claim 1 who has the absorber plate member which each other is optically accumulated on a top face by each layer of transparent cement, and is being fixed to the anterior part front face of a base, and in which two or more saturation is possible.

## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] The false monolithic light corpuscle child by the principle of this invention which has the absorber plate member in which the saturation of the number of arbitration is possible.

[Drawing 2] LiF:F2 - Room temperature absorption spectrum Fig. of a color center.

[Drawing 3] Cr<sup>4+</sup> - Room temperature absorption spectrum Fig. of doped GSGG.







